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Incorporating Balance, Resistance, and Aerobic Training into Therapy Sessions with a Patient who has MS: A Case Report

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Abstract

Background: Many of the symptoms associated with multiple sclerosis can negatively affect a person's ability to move and can in turn decrease their overall quality of life. Physical rehabilitation is considered one of the most effective ways to treat mobility deficits in those with multiple sclerosis. **Case Description:** The patient was a 66 year old woman with multiple sclerosis whose main impairment was general unsteadiness. She had recently experienced a fall which resulted in a left wrist fracture. The patient was referred to physical therapy for gait instability and left wrist pain. **Intervention Strategies**: The patient underwent three months of physical therapy with focuses initially placed on both static and dynamic balance training as well as wrist treatment. An additional emphasis on strength training and aerobic training were incorporated into the patient's therapy sessions one month into treatment. **Outcome Measures:** Main outcome measures collected during this case study included manual muscle testing of the lower extremities, a Berg Balance Scale, a Dynamic Gait Index, and an Activities-specific Balance Confidence Scale. A Twelve Item Multiple Sclerosis Walking Scale, 2 minute walk test, and peak torque values of knee extension and knee flexion were also collected but were unable to be further measured. **Discussion:** The purpose of this case report was to describe the strategies used to incorporate aerobic, resistance, and balance training into therapy sessions of an individual with MS, and to evaluate the response that the patient had to these interventions. The patient showed clinically significant improvements in both static and dynamic balance. Measurements related to the patient's strength and endurance were unable to be collected.

Introduction

Multiple Sclerosis (MS) is a neurological disease that affects 2.5 million people worldwide and 400,000 people in the United States alone.[1] Experts agree that genetic and environmental factors seem to play a role in causing this disease of the central nervous system.[2] Symptoms in those with MS commonly appear between the ages of 20 and 50 when individuals are in the peak of their careers and childrearing years.[1,3] These symptoms can include numbness or weakness in one or more limbs, tremor, spasticity, unsteady gait or difficulty maintaining balance, and fatigue.[1,4] It is one of the most common causes of non-traumatic disability in young adults.[5] Many of the symptoms associated with MS can cause someone to have a more sedentary lifestyle and contribute to a decreased quality of life. It is estimated that around 50% of those with MS require use of a gait aid and around 10% will require a wheelchair within 15 years of onset.[6]

Intervention strategies to help manage MS symptoms have evolved over time. Pharmacological interventions such as disease modifiers or corticosteroids continue to be a commonly used method to treat exacerbations or attacks and to slow disease progression. These strategies can be ineffective and often carry significant health risks such as increasing the risks of certain cancers.[4] It was previously believed that exercise should be avoided by those with MS. Physicians believed that there were adverse consequences to fatigue and overheating associated with exercise which were thought to potentially lead to exacerbations.[3] Research on this area has improved in both quality and quantity over time. It is now supported that those with MS can benefit from exercise programs to help manage their symptoms and to improve their mobility.[3]

Physical rehabilitation is considered to be one of the most effective ways of restoring function in individuals with MS.[7] More specifically, physical exercise has been shown to be an effective strategy in improving or restoring mobility deficits in those with MS.[7] Until recently, there was minimal research on which types of physical exercise were most effective.[7] The purpose of this case report is to describe the strategies used to incorporate aerobic, resistance, and balance training into therapy sessions of an individual with MS, and to evaluate the response that the patient had to these interventions.

Patient History

A 66 year old female was referred to physical therapy by her primary care physician. Her referral diagnosis was gait instability, secondary to MS, and left wrist pain, secondary to a left Colles' fracture. This fracture occurred as a result of a fall she had recently experienced. The patient fell due to fatigue that she was experiencing in her lower extremities. This was her second fall within the past year. The patient was first diagnosed with relapsing-remitting multiple sclerosis at the age of 28, and had not previously participated in physical therapy.

The patient owned a single point cane and a wheeled walker. She used her single point cane outside of her home and in physical therapy but rarely used her wheeled walker. An ankle-foot orthotic was utilized on the patient's right lower extremity as she had major deficits in strength in her right ankle. The patient reported that she commonly could not feel her feet at all. She noted difficulty walking on uneven surfaces and squatting down. She also had impairments in her vision. Because the patient's diagnoses either centered or were a result of an injury resulting from her balance impairments, the patient's lower extremity findings are the focus of this case report. Some of the patient's goals for physical therapy were to walk across her lawn to garden and sit by her willow tree (~1/4 mile distance) and to be able to more easily clean her cat's litter box.

Examination and Evaluation

The patient filled out an Activities-specific Balance Confidence (ABC) scale before being evaluated. The ABC is a scale in which the individual rates how confident they are in maintaining their balance or keeping a sense of steadiness while performing 16 daily living activities. Individuals rate how confident they are in accomplishing these activities on a scale from 0% confident to 100% confident. The average is then figured from the 16 activities. The ABC scale has shown to have a higher sensitivity rating than other commonly used static and dynamic balance tests when used in MS patient

populations and a comparable specificity rating, scoring 65% and 77% in these respective categories in a study done involving 51 patients with MS identifying fallers and non-fallers.[8] The patient had a score of 51.88% on the ABC scale. Scores of greater than 80 indicate a high level of functioning, scores of 50-80 indicate a medium level of functioning, and scores lower than 50 indicate a low level of functioning.[9]

Manual muscle tests were performed on the patient's lower extremities. Minimal deficits were found in her hip strength bilaterally, while major deficits were found in the patient's right ankle. Results can be found in Table 1a. A Berg Balance Scale (BBS) and a Dynamic Gait Index (DGI) were performed to further assess the patient's static and dynamic balance. The patient scored a 38/56 on the BBS and a 12/24 on the DGI with the use of a single point cane. The BBS and DGI are two widely used tests to measure static and dynamic stability, respectively, in patients with MS. Scores of less than 45 on the BBG indicate an individual may be at a greater risk for falling.[9] A score of less than 40 is associated with almost a 100% fall risk.[10] With the patient scoring a 38 on the BBG, she fell under both of these ranges. A score of less than or equal to 19 on the DGI is indicative of fall risks. With the patient scoring a 12/24, she was well below this value and is also classified as an increased fall risk.[9] In a study involving patients with MS, the BBS showed a sensitivity of 40% and a specificity of 90% and the DGI scored a sensitivity of 45% and a specificity of 85% in terms of correctly identifying fallers and non-fallers based off of determined cut-off values.[8] The BBS and DGI show a high probability of correctly identifying a faller, but also show a high probability of missing identification of a faller.

Upon observation of the patient's gait, the physical therapist determined that the patient ambulated with a decreased step length on her right side with a slight right hip hike. The patient also displayed a slight tremor contributing to her general unsteadiness. She ambulated with her single point cane in her right hand due to her left wrist injury. A slow gait speed was noted though not measured.

Clinical Impression

The primary problem that was determined by the physical therapist was static and dynamic instability. These were deficits that the patient had reported dealing with for several years. The physical therapist initially suggested to the patient that she begin to consider more extensive use of the two wheeled walker that she owned. This suggestion was met with resistance as the patient had determined this was not a step she was willing to take at this time to improve her stability. Based on the results from the objective portion of the examination, the patient was an appropriate candidate for further physical therapy in order to address balance deficits. The plan for intervention was based on the aspects of these tests that the patient had most difficulty with. Intervention strategies were also based on the patient's goals.

Interventions

Initial Month

In the first month following the initial evaluation, the patient was seen twice a week for 45 minute time slots. Each visit typically started with approximately 20 minutes devoted to improving the patient's left wrist strength and range of motion, with the remaining time working on improving her static and dynamic balance. The patient had the most difficulty on the BBS with turning to look behind her, turning 360 degrees, and with tandem stance. The emphasis in static balance training was intended to address these balance deficits. Static balance activities included: narrow base of support, semi tandem stance, weight shifts, gaze changes, and toe taps. These types of activities were performed on both firm and soft surfaces with use of parallel bars, a gait belt, and contact guard assist level from the physical therapist. The patient was also challenged at times to close her eyes during these activities to further challenge her static balance. Static balance exercises were typically performed for durations of 30 seconds to 1 minute with her eyes open and 10-15 seconds with her eyes closed. Periodic seated rest breaks were taken as needed.

Dynamic balance activities were also performed during therapy sessions in the initial month of physical therapy treatments. The patient had the most difficulty on the DGI with changes in gait speed,

stepping over obstacles, ascending/descending stairs, and gait on a level surface as she showed signs of imbalance. The emphasis on the patient's dynamic balance training was directed towards addressing these deficits. The therapy gym and surrounding hallways in the clinic were used for the patient to ambulate typically between 30-50 feet at a time. The physical therapist would cue the patient to increase speed, discourage a scissoring gait pattern, and increase stride length as needed. Obstacle courses were used to challenge the patient's dynamic gait with use of various objects for the patient to walk around, over, and to pick up off of the floor. Ambulation was commonly performed while challenging the patient to alter her gaze vertically and horizontally. For example, the patient was challenged to ambulate through the hallway where sticky notes with numbers had been preplaced on either side of the hallway and at different heights. The patient was instructed to scan up and down as well as left and right to find these numbers and read them aloud. Stair training was also performed and was used as a means of balance and strength training.

Several strength training exercises were incorporated into the patient's treatment, with 1 set of 10 repetitions typically performed. Closed chain activities included: sit to stand transfer, partial squats, and heel raises. Open chain activities included: standing hip extension, hip abduction, and resisted ankle motions using resistance bands. The patient also started each physical therapy session with 6-8 minutes on the NuStep for a warm-up and strengthening activity. She was given a home exercise program including hip strengthening exercises, knee extension strengthening exercises, ankle strengthening exercises, and balance activities to be performed in a corner with the assist of her husband for safety purposes.

Additional Months

Following the first month of treatment, the patient was re-evaluated by her orthopedic doctor where it was determined the patient would no longer need physical therapy for her left wrist as all goals had been met. The patient, physical therapist, and primary care physician decided it was in the patient's best interest to continue with therapy for balance deficits. The static and dynamic balance activities that were introduced to the patient throughout the first month of therapy treatment were continued and practiced to a greater extent throughout the second month of therapy, as the full session was able to be devoted to this area. The patient was also introduced to the Biodex Balance System which included many different static balance activities and provided the patient additional practice in weight transferring while also supplying immediate feedback.

The physical therapist also placed an increased emphasis on strengthening and aerobic activities in terms of time devoted to these areas. The patient continued with strengthening activities introduced in the first month of treatment but also was introduced to new activities such as the leg press machine, core exercises, and resisted marching. For aerobic activity, the patient continued to use the NuStep but was asked to maintain her cadence above 60 steps/min on level 7 for up to 8 minutes, which was a challenge for the patient. After this activity, the patient would commonly comment on how heavily she was breathing. The patient was also challenged at the end of therapy sessions by ambulating out to her car with no rest breaks. The patient continued her home exercise program with a focus on lower extremity strengthening as well as balance activities. She owned a recumbent bike at home and was encouraged to bike daily.

Outcomes

Using manual muscle testing (MMT), the patient's strength was largely unchanged after one month of therapy with the exception of increased right ankle strength (see Table 1b). The patient also showed a decrease in bilateral hip flexion strength. MMT was not re-evaluated at the 2-month re-assessment due to time constraints.

The patient's balance scores showed mixed results after two months of therapy (Table 2c). The patient gained 9 points on the BBS, indicating the patient was no longer in the fall risk category. The minimal clinically important difference (MCID) for the BBS in patients with MS is 3 points, thus her improvement likely was meaningful.[11] The patient gained 5 points on her DGI score which

approximates the MCID range reported as 4.19-5.54 points.[12] Though the patient had met the minimally important clinical difference, she still fell in the range of a high fall risk. The patient's score on the ABC scale decreased significantly when filled out at the 2-month re-assessment, but the patient admitted to filling this questionnaire out at that time with the belief that a high score would result in an earlier discharge from physical therapy which she did not want.

Additional outcome measures such as the Twelve Item MS Walking Scale, 2 Minute Walk Test, and isometric peak torque were utilized at the 2-month re-assessment as new means to track patient progress. The patient had been approved for more visits by her insurance provider and looked forward to continuing physical therapy. She continued with physical therapy for a few weeks after her 2-month re-assessment but unexpectedly discontinued due to personal reasons.

Table 1a. Manual Muscle Testing at Initial Evaluation

Right Lower Extremity Strength		Left Lower Extremity Strength	
Hip Flexion	4+	Hip Flexion	4+
Hip Abduction	4+	Hip Abduction	4+
Hip Adduction	4+	Hip Adduction	4+
Knee Flexion	4+	Knee Flexion	4+
Knee Extension	5	Knee Extension	5
Ankle Dorsiflexion	2+	Ankle Dorsiflexion	4+
Ankle Plantar Flexion	3+	Ankle Plantar Flexion	4+

Table 1b. Manual Muscle Testing at 1 Month Progress Report

Right Lower Extremity Strength		Left Lower Extremity Strength	
Hip Flexion	4	Hip Flexion	4
Hip Abduction	4+	Hip Abduction	4+
Hip Adduction	4+	Hip Adduction	4+
Knee Flexion	4+	Knee Flexion	4+
Knee Extension	5	Knee Extension	5
Ankle Dorsiflexion	4-	Ankle Dorsiflexion	4+
Ankle Plantar Flexion	4-	Ankle Plantar Flexion	4+

Table 1c. Manual Muscle Testing at 2 Month Progress Report

*Not assessed due to time constraints within session

Table 2a. Outcomes Assessments Utilized at Initial Evaluation

ABC Scale at Initial Evaluation	51.88%
Berg Balance Scale at Initial Evaluation	38/56
Dynamic Gait Index at Initial Evaluation	12/24

Table 2b. Outcomes Assessments Utilized at 1 Month Progress Report

ABC Scale at Initial Evaluation	52.19%
Berg Balance Scale at Initial Evaluation	41/56
Dynamic Gait Index at Initial Evaluation	12/24

Table 2c. Outcomes Assessments Utilized at 2 Month Progress Report

ABC Scale at Initial Evaluation	40% *
Berg Balance Scale at Initial Evaluation	47/56
Dynamic Gait Index at Initial Evaluation	17/24
Twelve Item MS Walking Scale	40/60 (66%)
2 Minute Walk Test	82 feet (25 meters)

* Patient stated after filling out ABC Scale she was afraid a high score would result in cessation of therapy sessions

Table 2c. (continued) Isometric Peak Torque at 2 Month Progress Report**

Right Lower Extremity		Left Lower Extremity	
Knee Flexion	20 lbs.	Knee Flexion	17 lbs.
Knee Extension	19 lbs.	Knee Extension	20 lbs.

**Measured 20 cm superior to lateral malleolus

Discussion

The purpose of this case report was to describe the strategies used to incorporate aerobic, resistance, and balance training into therapy sessions of an individual with MS, and to evaluate the response that the patient had to these interventions. The patient's treatment strategy was initially aimed at improving the patient's steadiness to in turn decrease her risk of falling. The treatment strategy later evolved to become multimodal, with an added emphasis on strength and aerobic training. Improvements in balance more than strength were observed, with a notable improvement in her BBS score and reduced fall risk after 2 months of treatment.

The improvement seen in this patient is consistent with previous studies that have shown balance training to be effective in MS patient populations. In a study done by Cattaneo et al[12] involving 50 patients with MS, static and dynamic balance were challenged with similar strategies described in this paper such as eyes-closed conditions, gaze changes, and use of foam pads. The study intervention took place over the course of three weeks and included 10-12 sessions for 45 minutes each. Treatments were individualized and based off of patient presentation. Clinically relevant improvements were seen in both BBS and DGI scores compared to a control group which received "conventional therapy" with no specific emphasis on balance training. In different study done by Gandolfi et al[13] involving 80 patients with MS, static balance was challenged using blindfolds, foam pads of different thicknesses, perturbations by the physical therapist, and visual-conflict domes to produce inaccurate sensory inputs. A control group was created in which patients received joint mobilizations, performed muscle stretching, and did strengthening exercises. The group receiving physical therapy with balance training as an emphasis had higher improvements on the BBS, reduced number of falls, and reduced fatigue levels compared to the control group.

Along with balance training, other forms of exercise training have shown to be effective in the treatment of those with MS. The MS disease process can often result in physical inactivity which can result in deconditioning and worsening of MS symptoms.[7] In a study done by Sandroff et al[7] involving 83 patients with substantial mobility disability from MS it was shown that a multimodal exercise approach was effective in improving mobility. Progressive aerobic, resistance, and balance training were performed with statistically significant improvements shown in six-minute walk performance and peak power outputs compared to the control group. The control group involved stretching and toning activities with active range of motion and low load resistance bands. In a review of literature done in the Current Neurology and Neuroscience Reports in 2015 by Motl and Sandroff[14] it was determined that literature suggests exercise training can improve walking, symptoms of depression and fatigue, and overall quality of life in patients with MS.

This case highlights the implementation of balance training in a patient with MS that initially presented to PT primarily due to a fall-related injury. However, the balance impairment, along with strength and endurance deficits, was the focus of longer-term therapy intervention in an effort to reduce her future fall risk. While final outcome measures intended to measure strength and endurance were not able to be collected due to discontinuation of therapy, balance assessments at the 2 month re-assessment point showed improvement despite minimal change in lower extremity strength. Additional outcome measures such as five times sit to stand, Multiple Sclerosis Quality of Life Questionnaire, timed up and go test, timed 25 foot walk, sensory testing, and many others would also be good candidates for outcomes to better evaluate patient responses to interventions in regards to balance, strength, and endurance.

Conclusion

The case report described the strategies that were used to incorporate aerobic, resistance, and balance training into therapy sessions of a patient with MS and evaluated the response that the patient had to these strategies. Outcome measures utilized indicated that the patient had a positive response to balance training. A lack of a collection of outcome measures resulted in the inability to adequately measure the response of the patient to strengthening and aerobic training. Further research on the effects of aerobic, resistance, and balance training in the MS patient population involving a larger sample size would be beneficial in learning how best to treat patients with MS.

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